Full wwPDB X-ray Structure Validation Report (i)

Aug 3, 2023 – 08:21 AM EDT

PDB ID	:	1I54
Title	:	CYTOCHROME C (TUNA) 2FE:1ZN MIXED-METAL PORPHYRINS
Authors	:	Crane, B.R.; Tezcan, F.A.; Winkler, J.R.; Gray, H.B.
Deposited on	:	2001-02-24
Resolution	:	1.50 Å(reported)

This is a Full wwPDB X-ray Structure Validation Report for a publicly released PDB entry.

We welcome your comments at *validation@mail.wwpdb.org*
A user guide is available at
https://www.wwpdb.org/validation/2017/XrayValidationReportHelp
with specific help available everywhere you see the (i) symbol.

The types of validation reports are described at
http://www.wwpdb.org/validation/2017/FAQs#types.

The following versions of software and data (see references (1)) were used in the production of this report:

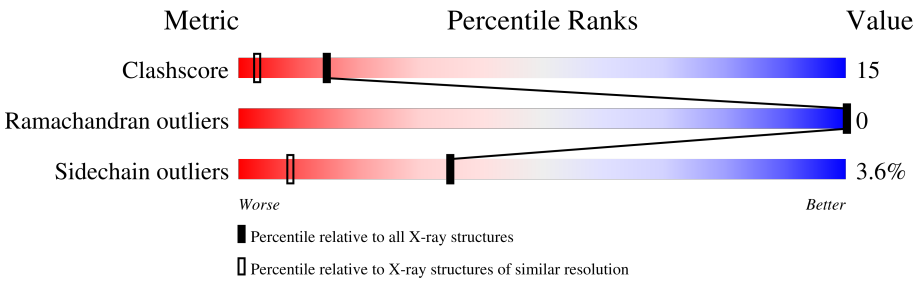
MolProbity	:	4.02b-467
Mogul	:	1.8.5 (274361), CSD as541be (2020)
Xtriage (Phenix)	:	NOT EXECUTED
EDS	:	NOT EXECUTED
buster-report	:	1.1.7 (2018)
Percentile statistics	:	20191225.v01 (using entries in the PDB archive December 25th 2019)
Ideal geometry (proteins)	:	Engh & Huber (2001)
Ideal geometry (DNA, RNA)	:	Parkinson et al. (1996)
Validation Pipeline (wwPDB-VP)	:	2.34

1 Overall quality at a glance (i)

The following experimental techniques were used to determine the structure:
X-RAY DIFFRACTION

The reported resolution of this entry is 1.50 Å.

Percentile scores (ranging between 0-100) for global validation metrics of the entry are shown in the following graphic. The table shows the number of entries on which the scores are based.



Metric	Whole archive (#Entries)	Similar resolution (#Entries, resolution range(Å))
Clashscore	141614	3144 (1.50-1.50)
Ramachandran outliers	138981	3066 (1.50-1.50)
Sidechain outliers	138945	3064 (1.50-1.50)

The table below summarises the geometric issues observed across the polymeric chains and their fit to the electron density. The red, orange, yellow and green segments of the lower bar indicate the fraction of residues that contain outliers for >=3, 2, 1 and 0 types of geometric quality criteria respectively. A grey segment represents the fraction of residues that are not modelled. The numeric value for each fraction is indicated below the corresponding segment, with a dot representing fractions <=5%

Note EDS was not executed.

Mol	Chain	Length	Quality of chain
1	A	103	85% 13% •
1	B	103	78% 20% •

2 Entry composition (i)

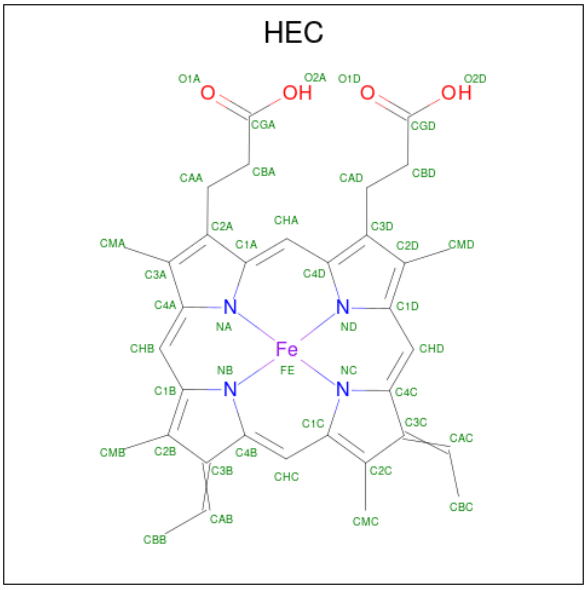
There are 4 unique types of molecules in this entry. The entry contains 2142 atoms, of which 0 are hydrogens and 0 are deuteriums.

In the tables below, the ZeroOcc column contains the number of atoms modelled with zero occupancy, the AltConf column contains the number of residues with at least one atom in alternate conformation and the Trace column contains the number of residues modelled with at most 2 atoms.

- Molecule 1 is a protein called CYTOCHROME C.

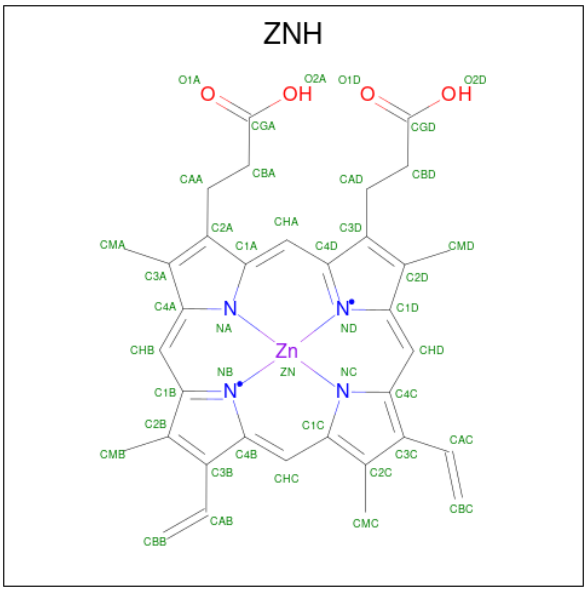
Mol	Chain	Residues	Atoms					ZeroOcc	AltConf	Trace
			Total	C	N	O	S			
1	A	103	800	507	141	148	4	0	0	0
1	B	103	800	507	141	148	4	0	0	0

- Molecule 2 is HEME C (three-letter code: HEC) (formula: $C_{34}H_{34}FeN_4O_4$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	Fe	N	O		
2	A	1	43	34	1	4	4	0	1
2	B	1	43	34	1	4	4	0	1

- Molecule 3 is PROTOPORPHYRIN IX CONTAINING ZN (three-letter code: ZNH) (formula: $C_{34}H_{32}N_4O_4Zn$).



Mol	Chain	Residues	Atoms					ZeroOcc	AltConf
			Total	C	N	O	Zn		
3	A	1	43	34	4	4	1	0	1
			Total	C	N	O	Zn		
3	B	1	43	34	4	4	1	0	1

- Molecule 4 is water.

Mol	Chain	Residues	Atoms		ZeroOcc	AltConf
			Total	O		
4	A	197	197	197	0	0
			Total	O		
4	B	173	173	173	0	0

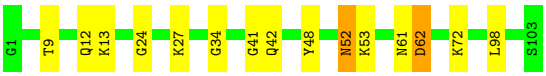
3 Residue-property plots (i)

These plots are drawn for all protein, RNA, DNA and oligosaccharide chains in the entry. The first graphic for a chain summarises the proportions of the various outlier classes displayed in the second graphic. The second graphic shows the sequence view annotated by issues in geometry. Residues are color-coded according to the number of geometric quality criteria for which they contain at least one outlier: green = 0, yellow = 1, orange = 2 and red = 3 or more. Stretches of 2 or more consecutive residues without any outlier are shown as a green connector. Residues present in the sample, but not in the model, are shown in grey.

Note EDS was not executed.

• Molecule 1: CYTOCHROME C

Chain A: 85% 13% •



• Molecule 1: CYTOCHROME C

Chain B: 78% 20% •

4 Data and refinement statistics (i)

Xtriage (Phenix) and EDS were not executed - this section is therefore incomplete.

Property	Value	Source
Space group	P 43	Depositor
Cell constants a, b, c, α, β, γ	74.18Å 74.18Å 35.54Å 90.00° 90.00° 90.00°	Depositor
Resolution (Å)	21.10 – 1.50	Depositor
% Data completeness (in resolution range)	86.9 (21.10-1.50)	Depositor
R_{merge}	0.07	Depositor
R_{sym}	(Not available)	Depositor
Refinement program	CNS 1.0	Depositor
R, R_{free}	0.226 , 0.247	Depositor
Estimated twinning fraction	No twinning to report.	Xtriage
Total number of atoms	2142	wwPDB-VP
Average B, all atoms (Å^2)	14.0	wwPDB-VP

5 Model quality (i)

5.1 Standard geometry (i)

Bond lengths and bond angles in the following residue types are not validated in this section: ZNH, HEC

The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 5$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Chain	Bond lengths		Bond angles	
		RMSZ	$\#\|Z\| >5$	RMSZ	$\#\|Z\| >5$
1	A	0.41	0/816	0.64	0/1091
1	B	0.39	1/816 (0.1%)	0.64	0/1091
All	All	0.40	1/1632 (0.1%)	0.64	0/2182

All (1) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
1	B	21	GLU	CG-CD	5.09	1.59	1.51

There are no bond angle outliers.

There are no chirality outliers.

There are no planarity outliers.

5.2 Too-close contacts (i)

In the following table, the Non-H and H(model) columns list the number of non-hydrogen atoms and hydrogen atoms in the chain respectively. The H(added) column lists the number of hydrogen atoms added and optimized by MolProbity. The Clashes column lists the number of clashes within the asymmetric unit, whereas Symm-Clashes lists symmetry-related clashes.

Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
1	A	800	0	810	16	0
1	B	800	0	810	35	0
2	A	43	0	30	1	0
2	B	43	0	30	1	0
3	A	43	0	28	0	0
3	B	43	0	28	2	0
4	A	197	0	0	15	0
4	B	173	0	0	23	0

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Mol	Chain	Non-H	H(model)	H(added)	Clashes	Symm-Clashes
All	All	2142	0	1736	52	0

The all-atom clashscore is defined as the number of clashes found per 1000 atoms (including hydrogen atoms). The all-atom clashscore for this structure is 15.

All (52) close contacts within the same asymmetric unit are listed below, sorted by their clash magnitude.

Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:24:GLY:HA2	4:A:1288:HOH:O	1.79	0.83
1:A:61:ASN:HB2	4:A:1272:HOH:O	1.79	0.80
1:B:85:ILE:HG12	4:B:1234:HOH:O	1.82	0.78
1:B:41:GLY:HA3	4:B:1261:HOH:O	1.87	0.75
1:B:17:CYS:SG	2:B:1106[A]:HEC:C3C	2.75	0.74
1:A:41:GLY:HA3	4:A:1270:HOH:O	1.93	0.68
1:B:17:CYS:SG	3:B:1107[B]:ZNH:CBC	2.80	0.67
1:B:85:ILE:HB	1:B:91:ARG:HG2	1.77	0.66
1:B:88:LYS:HG3	4:B:1181:HOH:O	1.96	0.66
1:B:72:LYS:HD3	4:B:1240:HOH:O	1.96	0.65
1:B:87:LYS:HE2	4:B:1260:HOH:O	1.97	0.65
1:A:62:ASP:HB2	4:A:1246:HOH:O	1.98	0.64
1:A:27:LYS:HD2	4:A:1283:HOH:O	2.04	0.57
1:B:85:ILE:HD11	1:B:94:LEU:HD22	1.87	0.57
1:A:41:GLY:CA	4:A:1270:HOH:O	2.53	0.56
1:B:8:LYS:HE2	4:B:1256:HOH:O	2.05	0.56
1:B:13:LYS:HD3	4:B:1234:HOH:O	2.08	0.53
1:B:41:GLY:CA	4:B:1261:HOH:O	2.53	0.53
1:B:99:LYS:HG2	4:B:1191:HOH:O	2.09	0.51
1:B:2:ASP:HB2	4:B:1192:HOH:O	2.10	0.51
1:B:39:LYS:HG2	4:B:1252:HOH:O	2.11	0.50
1:B:60:ASN:HB2	4:B:1243:HOH:O	2.11	0.50
1:A:27:LYS:CD	4:A:1283:HOH:O	2.58	0.49
1:B:10:PHE:CZ	1:B:20:VAL:HG13	2.46	0.49
1:B:17:CYS:SG	3:B:1107[B]:ZNH:C3C	2.75	0.49
1:A:41:GLY:HA2	1:A:48:TYR:CZ	2.47	0.49
1:A:53:LYS:HG2	4:A:1286:HOH:O	2.12	0.49
1:B:72:LYS:HB2	1:B:72:LYS:NZ	2.28	0.49
1:B:60:ASN:ND2	4:B:1249:HOH:O	2.36	0.49
1:A:52:ASN:ND2	4:A:1270:HOH:O	2.46	0.48
1:A:42:GLN:NE2	4:A:1248:HOH:O	2.46	0.48
1:A:52:ASN:C	4:A:1270:HOH:O	2.53	0.47
1:B:91:ARG:NH2	4:B:1181:HOH:O	2.46	0.47

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Atom-1	Atom-2	Interatomic distance (Å)	Clash overlap (Å)
1:A:12:GLN:NE2	4:A:1278:HOH:O	2.47	0.47
1:B:38:ARG:HB3	4:B:1201:HOH:O	2.14	0.47
1:B:52:ASN:C	4:B:1261:HOH:O	2.53	0.47
1:B:52:ASN:HB3	4:B:1261:HOH:O	2.15	0.47
2:A:1104[A]:HEC:HMC1	2:A:1104[A]:HEC:HBC3	1.98	0.46
1:B:85:ILE:CD1	1:B:94:LEU:HD22	2.46	0.46
1:B:41:GLY:HA2	1:B:48:TYR:CZ	2.51	0.45
1:B:52:ASN:ND2	4:B:1261:HOH:O	2.52	0.42
1:A:9:THR:HA	4:A:1278:HOH:O	2.20	0.42
1:B:39:LYS:HE2	4:B:1252:HOH:O	2.18	0.42
1:B:39:LYS:CG	4:B:1252:HOH:O	2.67	0.42
1:B:87:LYS:HE3	4:B:1156:HOH:O	2.20	0.41
1:B:3:VAL:HG13	1:B:97:TYR:HA	2.03	0.41
1:B:28:VAL:HG23	4:B:1196:HOH:O	2.21	0.41
1:A:34:GLY:HA3	4:A:1285:HOH:O	2.20	0.41
1:B:91:ARG:HG3	1:B:91:ARG:HH11	1.86	0.40
1:B:52:ASN:CB	4:B:1261:HOH:O	2.68	0.40
1:A:13:LYS:NZ	4:A:1302:HOH:O	2.47	0.40
1:B:41:GLY:HA2	1:B:48:TYR:CE1	2.56	0.40

There are no symmetry-related clashes.

5.3 Torsion angles (i)

5.3.1 Protein backbone (i)

In the following table, the Percentiles column shows the percent Ramachandran outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the backbone conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Favoured	Allowed	Outliers	Percentiles	
1	A	101/103 (98%)	99 (98%)	2 (2%)	0	100	100
1	B	101/103 (98%)	98 (97%)	3 (3%)	0	100	100
All	All	202/206 (98%)	197 (98%)	5 (2%)	0	100	100

There are no Ramachandran outliers to report.

5.3.2 Protein sidechains (i)

In the following table, the Percentiles column shows the percent sidechain outliers of the chain as a percentile score with respect to all X-ray entries followed by that with respect to entries of similar resolution.

The Analysed column shows the number of residues for which the sidechain conformation was analysed, and the total number of residues.

Mol	Chain	Analysed	Rotameric	Outliers	Percentiles
1	A	83/83 (100%)	79 (95%)	4 (5%)	25 4
1	B	83/83 (100%)	81 (98%)	2 (2%)	49 19
All	All	166/166 (100%)	160 (96%)	6 (4%)	35 8

All (6) residues with a non-rotameric sidechain are listed below:

Mol	Chain	Res	Type
1	A	52	ASN
1	A	62	ASP
1	A	72	LYS
1	A	98	LEU
1	B	52	ASN
1	B	72	LYS

Sometimes sidechains can be flipped to improve hydrogen bonding and reduce clashes. All (2) such sidechains are listed below:

Mol	Chain	Res	Type
1	A	12	GLN
1	B	92	GLN

5.3.3 RNA (i)

There are no RNA molecules in this entry.

5.4 Non-standard residues in protein, DNA, RNA chains (i)

There are no non-standard protein/DNA/RNA residues in this entry.

5.5 Carbohydrates (i)

There are no monosaccharides in this entry.

5.6 Ligand geometry (i)

4 ligands are modelled in this entry.

In the following table, the Counts columns list the number of bonds (or angles) for which Mogul statistics could be retrieved, the number of bonds (or angles) that are observed in the model and the number of bonds (or angles) that are defined in the Chemical Component Dictionary. The Link column lists molecule types, if any, to which the group is linked. The Z score for a bond length (or angle) is the number of standard deviations the observed value is removed from the expected value. A bond length (or angle) with $|Z| > 2$ is considered an outlier worth inspection. RMSZ is the root-mean-square of all Z scores of the bond lengths (or angles).

Mol	Type	Chain	Res	Link	Bond lengths			Bond angles		
					Counts	RMSZ	$\#\|Z\| > 2$	Counts	RMSZ	$\#\|Z\| > 2$
3	ZNH	B	1107[B]	1	36,50,50	1.42	5 (13%)	39,82,82	2.03	12 (30%)
3	ZNH	A	1105[B]	1	36,50,50	1.37	4 (11%)	39,82,82	2.00	11 (28%)
2	HEC	A	1104[A]	1	32,50,50	1.21	4 (12%)	24,82,82	1.82	7 (29%)
2	HEC	B	1106[A]	1	32,50,50	1.31	4 (12%)	24,82,82	1.76	7 (29%)

In the following table, the Chirals column lists the number of chiral outliers, the number of chiral centers analysed, the number of these observed in the model and the number defined in the Chemical Component Dictionary. Similar counts are reported in the Torsion and Rings columns. '-' means no outliers of that kind were identified.

Mol	Type	Chain	Res	Link	Chirals	Torsions	Rings
3	ZNH	B	1107[B]	1	-	4/12/94/94	-
3	ZNH	A	1105[B]	1	-	4/12/94/94	-
2	HEC	A	1104[A]	1	-	2/10/54/54	-
2	HEC	B	1106[A]	1	-	2/10/54/54	-

All (17) bond length outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
3	B	1107[B]	ZNH	C3C-CAC	-3.99	1.39	1.47
2	B	1106[A]	HEC	C2B-C3B	-3.81	1.36	1.40
3	A	1105[B]	ZNH	C3C-CAC	-3.77	1.40	1.47
3	A	1105[B]	ZNH	CAB-C3B	-3.11	1.39	1.47
2	A	1104[A]	HEC	C2B-C3B	-3.09	1.37	1.40
3	B	1107[B]	ZNH	CAB-C3B	-3.02	1.39	1.47
2	B	1106[A]	HEC	C3C-C2C	-2.81	1.37	1.40
2	A	1104[A]	HEC	CBC-CAC	-2.54	1.40	1.49
3	A	1105[B]	ZNH	C3C-C4C	2.49	1.46	1.40
2	A	1104[A]	HEC	CBB-CAB	-2.47	1.40	1.49

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Mol	Chain	Res	Type	Atoms	Z	Observed(Å)	Ideal(Å)
2	A	1104[A]	HEC	C3C-C2C	-2.47	1.38	1.40
2	B	1106[A]	HEC	CBB-CAB	-2.43	1.40	1.49
2	B	1106[A]	HEC	CBC-CAC	-2.29	1.40	1.49
3	B	1107[B]	ZNH	C3C-C4C	2.25	1.46	1.40
3	B	1107[B]	ZNH	C4D-ND	2.11	1.38	1.35
3	B	1107[B]	ZNH	CHD-C1D	2.09	1.41	1.37
3	A	1105[B]	ZNH	C4D-ND	2.01	1.38	1.35

All (37) bond angle outliers are listed below:

Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	A	1105[B]	ZNH	C2A-C1A-NA	-5.11	109.63	115.57
3	B	1107[B]	ZNH	C2A-C1A-NA	-4.91	109.86	115.57
2	A	1104[A]	HEC	CBD-CAD-C3D	-4.70	104.60	112.62
2	B	1106[A]	HEC	CBD-CAD-C3D	-4.62	104.73	112.62
3	B	1107[B]	ZNH	C3A-C4A-NA	-4.53	110.31	115.57
3	A	1105[B]	ZNH	C2C-C1C-NC	-4.28	110.60	115.57
3	A	1105[B]	ZNH	C3A-C4A-NA	-4.23	110.66	115.57
3	B	1107[B]	ZNH	C2C-C1C-NC	-4.12	110.79	115.57
3	A	1105[B]	ZNH	C1D-CHD-C4C	3.41	127.90	118.67
2	A	1104[A]	HEC	CMC-C2C-C1C	-3.40	123.24	128.46
3	B	1107[B]	ZNH	C1D-CHD-C4C	3.40	127.86	118.67
3	B	1107[B]	ZNH	C4D-CHA-C1A	3.39	127.85	118.67
3	B	1107[B]	ZNH	C1B-CHB-C4A	3.28	127.55	118.67
3	A	1105[B]	ZNH	C1B-CHB-C4A	3.24	127.42	118.67
2	A	1104[A]	HEC	CMC-C2C-C3C	3.14	129.51	125.82
3	B	1107[B]	ZNH	C4B-CHC-C1C	3.14	127.15	118.67
3	A	1105[B]	ZNH	C4B-CHC-C1C	3.12	127.10	118.67
2	B	1106[A]	HEC	CBA-CAA-C2A	-2.98	107.58	112.60
3	A	1105[B]	ZNH	C4D-CHA-C1A	2.95	126.66	118.67
3	B	1107[B]	ZNH	CBD-CAD-C3D	-2.75	105.07	112.62
2	B	1106[A]	HEC	CMC-C2C-C1C	-2.73	124.26	128.46
3	B	1107[B]	ZNH	CBA-CAA-C2A	-2.70	108.05	112.60
2	B	1106[A]	HEC	CMB-C2B-C1B	-2.66	124.37	128.46
2	B	1106[A]	HEC	CMC-C2C-C3C	2.64	128.93	125.82
3	A	1105[B]	ZNH	CBD-CAD-C3D	-2.61	105.44	112.62
3	A	1105[B]	ZNH	CMC-C2C-C3C	2.57	129.48	124.68
2	A	1104[A]	HEC	CMD-C2D-C1D	-2.43	124.72	128.46
2	B	1106[A]	HEC	CMB-C2B-C3B	2.38	128.62	125.82
2	A	1104[A]	HEC	CMB-C2B-C3B	2.34	128.57	125.82
3	B	1107[B]	ZNH	C3D-C4D-ND	-2.31	109.92	115.01
3	A	1105[B]	ZNH	C3D-C4D-ND	-2.29	109.96	115.01

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Mol	Chain	Res	Type	Atoms	Z	Observed(^{o})	Ideal(^{o})
3	B	1107[B]	ZNH	CMC-C2C-C3C	2.28	128.94	124.68
3	A	1105[B]	ZNH	CBA-CAA-C2A	-2.24	108.83	112.60
2	A	1104[A]	HEC	CMB-C2B-C1B	-2.23	125.03	128.46
2	B	1106[A]	HEC	CMD-C2D-C1D	-2.17	125.13	128.46
2	A	1104[A]	HEC	CBA-CAA-C2A	-2.14	108.99	112.60
3	B	1107[B]	ZNH	C1D-C2D-C3D	-2.07	106.89	108.61

There are no chirality outliers.

All (12) torsion outliers are listed below:

Mol	Chain	Res	Type	Atoms
3	B	1107[B]	ZNH	C2B-C3B-CAB-CBB
3	A	1105[B]	ZNH	C2B-C3B-CAB-CBB
3	A	1105[B]	ZNH	C4B-C3B-CAB-CBB
3	B	1107[B]	ZNH	C4B-C3B-CAB-CBB
2	A	1104[A]	HEC	CAA-CBA-CGA-O2A
3	A	1105[B]	ZNH	CAA-CBA-CGA-O2A
2	A	1104[A]	HEC	CAA-CBA-CGA-O1A
3	A	1105[B]	ZNH	CAA-CBA-CGA-O1A
3	B	1107[B]	ZNH	CAA-CBA-CGA-O2A
2	B	1106[A]	HEC	CAA-CBA-CGA-O2A
2	B	1106[A]	HEC	CAA-CBA-CGA-O1A
3	B	1107[B]	ZNH	CAA-CBA-CGA-O1A

There are no ring outliers.

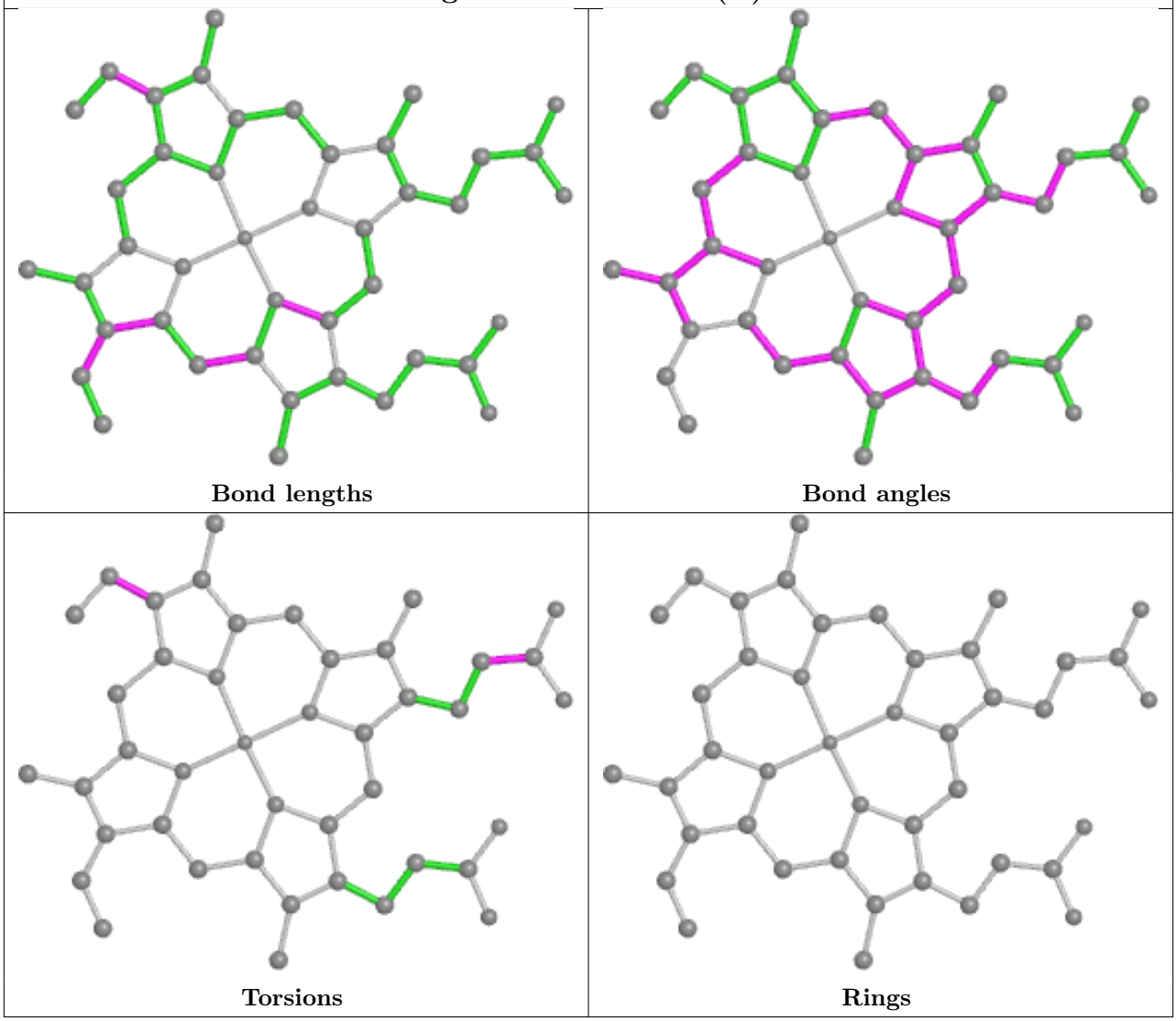
3 monomers are involved in 4 short contacts:

Mol	Chain	Res	Type	Clashes	Symm-Clashes
3	B	1107[B]	ZNH	2	0
2	A	1104[A]	HEC	1	0
2	B	1106[A]	HEC	1	0

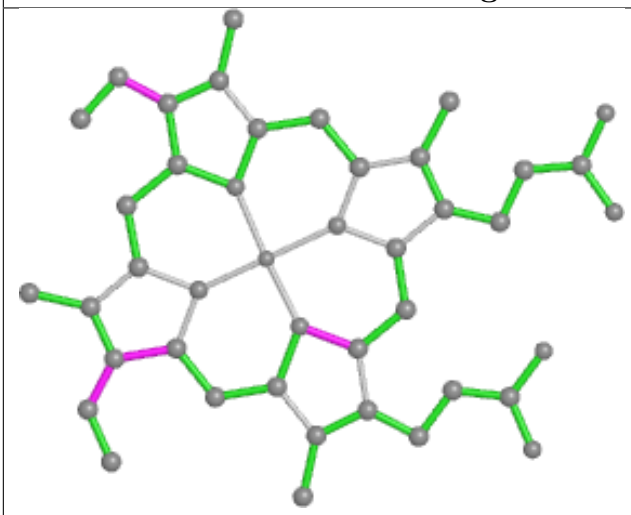
The following is a two-dimensional graphical depiction of Mogul quality analysis of bond lengths, bond angles, torsion angles, and ring geometry for all instances of the Ligand of Interest. In addition, ligands with molecular weight > 250 and outliers as shown on the validation Tables will also be included. For torsion angles, if less then 5% of the Mogul distribution of torsion angles is within 10 degrees of the torsion angle in question, then that torsion angle is considered an outlier. Any bond that is central to one or more torsion angles identified as an outlier by Mogul will be highlighted in the graph. For rings, the root-mean-square deviation (RMSD) between the ring in question and similar rings identified by Mogul is calculated over all ring torsion angles. If the average RMSD is greater than 60 degrees and the minimal RMSD between the ring in question and any Mogul-identified rings is also greater than 60 degrees, then that ring is considered an outlier.

The outliers are highlighted in purple. The color gray indicates Mogul did not find sufficient equivalents in the CSD to analyse the geometry.

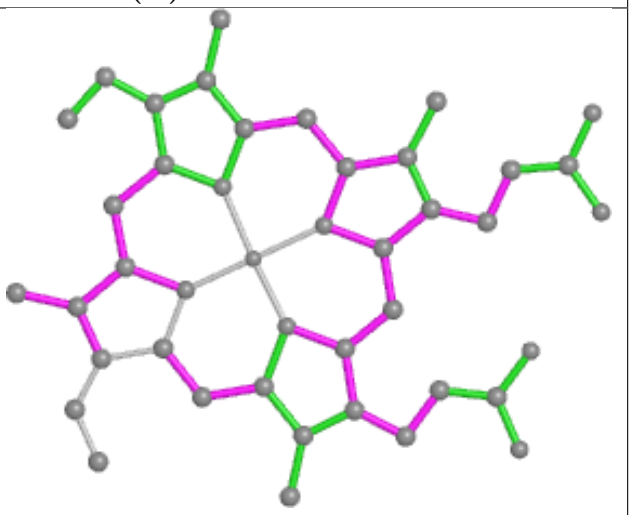
Ligand ZNH B 1107 (B)



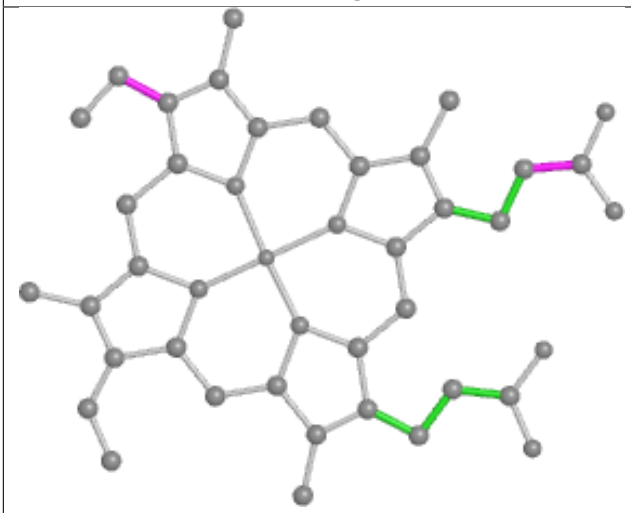
Ligand ZNH A 1105 (B)



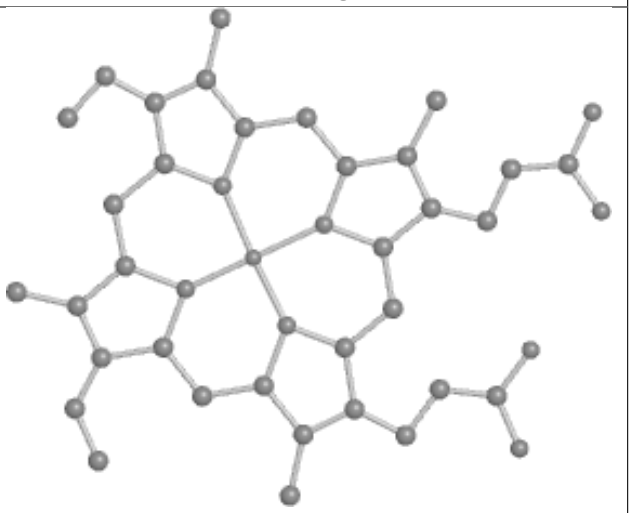
Bond lengths



Bond angles

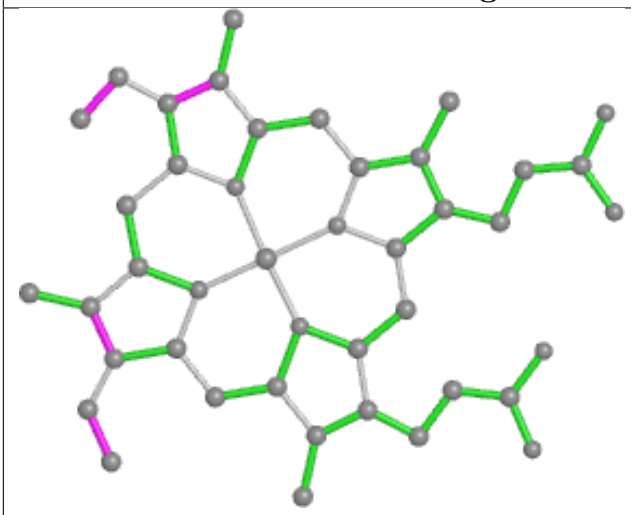


Torsions

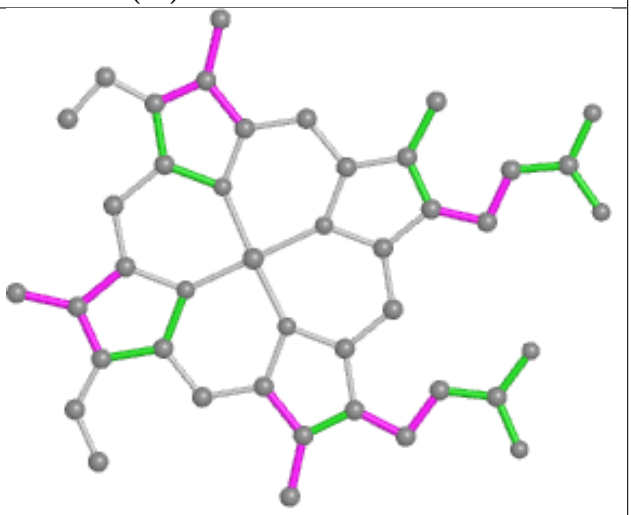


Rings

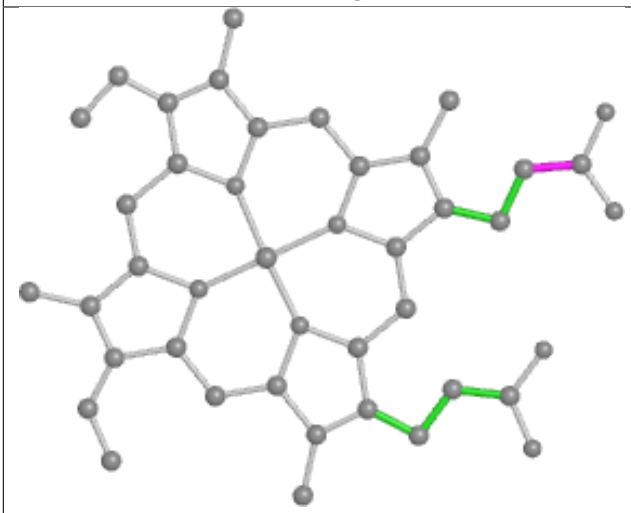
Ligand HEC A 1104 (A)



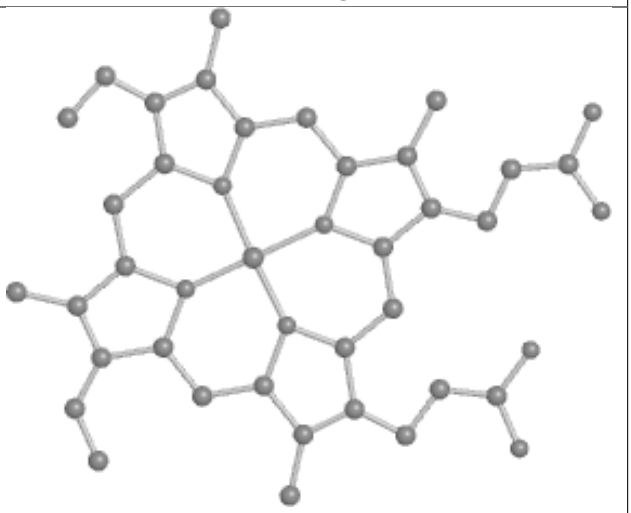
Bond lengths



Bond angles

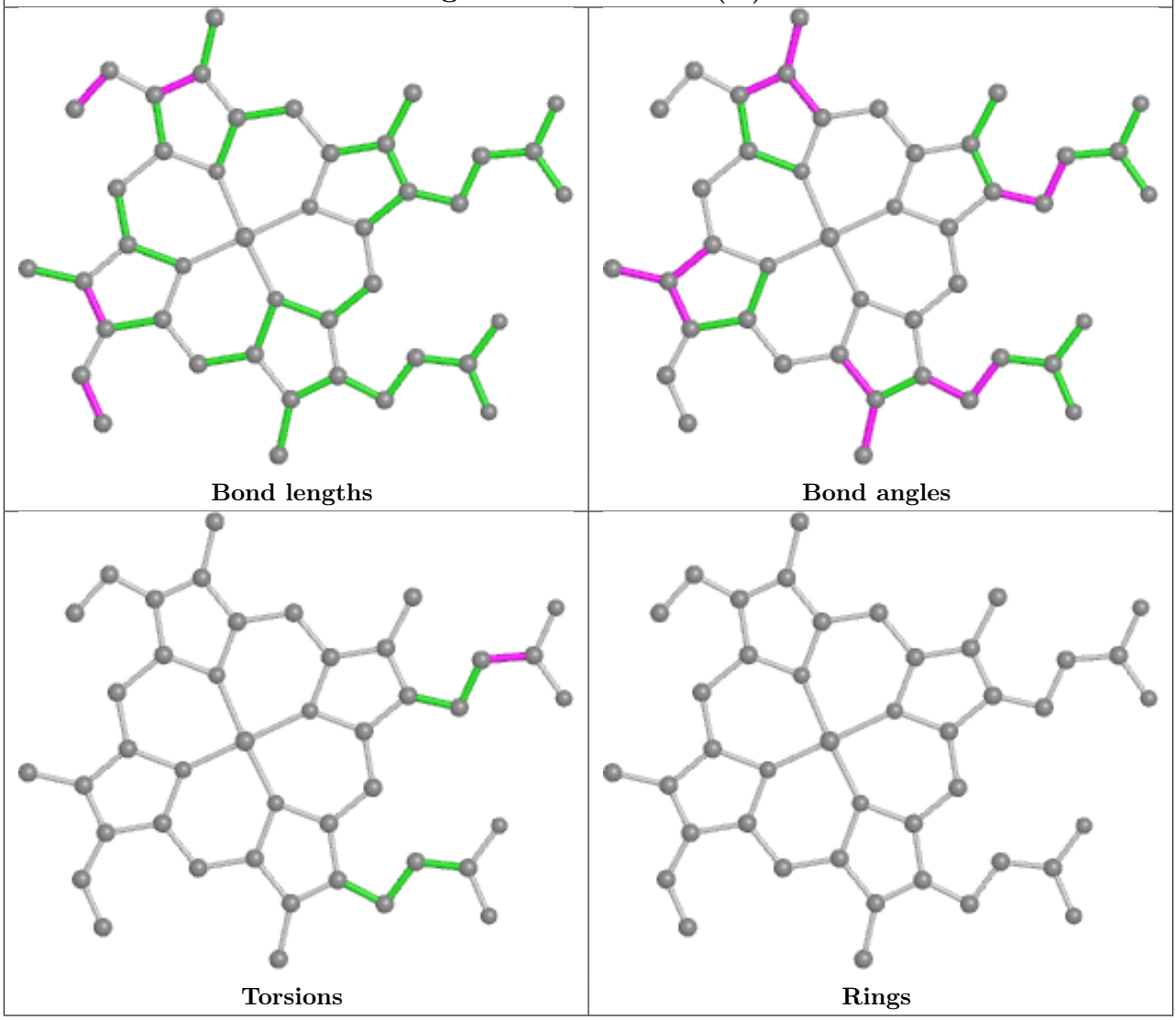


Torsions



Rings

Ligand HEC B 1106 (A)



5.7 Other polymers (i)

There are no such residues in this entry.

5.8 Polymer linkage issues (i)

There are no chain breaks in this entry.

6 Fit of model and data (i)

6.1 Protein, DNA and RNA chains (i)

EDS was not executed - this section is therefore empty.

6.2 Non-standard residues in protein, DNA, RNA chains (i)

EDS was not executed - this section is therefore empty.

6.3 Carbohydrates (i)

EDS was not executed - this section is therefore empty.

6.4 Ligands (i)

EDS was not executed - this section is therefore empty.

6.5 Other polymers (i)

EDS was not executed - this section is therefore empty.